

DEVELOPING THE PLASTIC GREEN SUPPLY CHAIN MANAGEMENT FRAMEWORK AND IMPLEMENTATION STRATEGY TO DELIVER THE SUSTAINABILITY NEEDS OF PLASTIC PROCESSING INDUSTRIES

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ABSTRACT

By developing a competitive advantage, environmentally and socially friendly supply chain practices enable businesses to achieve economic sustainability. Although issues related to extended producer responsibility (EPR) also put additional pressure on businesses to develop green policies, plastic recycling is a legal requirement and can bring benefits to the environment, social, health and safety. In order to promote a better understanding of the importance of supply chain management performance categories and metrics across its supply chain, we developed a methodological framework for small and micro scale plastic processors. Performance metrics play an important role in setting plastic green supply chain management framework, evaluating performance, and identifying future course of action. The proposed framework for the plastic green supply chain (PGSCMF) outlines the taxonomy and implementation of green supply chain practices in real business case studies. The framework will act as a flexible reference tool for managers in the plastics companies of small and micro scale to bring greater continuity to undertake the necessary improvements at a very local and specific level.

KEYWORDS: SCM, GSCM, PGSCM, PGSCMF, Performance Metrics & Performance Categories

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INTRODUCTION

Plastics are clearly an important component of the range of materials that are used in modern society. In India, the packaging sector reported 43% of resin consumption in 2017-18 [FICCI 2017]. In the developing world, the use of plastics is increasing as the lower unit cost and performance specification improvements are continuously promoting their substitution for materials such as paper, metals, wood and glass. While, nearly all aspects of everyday life involve plastics in some form or the other, there are real and perceived issues related to plastic processing industries sustainable credentials [FICCI 2017, Brockhaus et al., 2016 and Schulze et al., 2017]. Plastic is invariably branded as a polluting material. Plastics, being a crude - derived polymer, consist of long carbon chains. It takes them years to completely decompose. Improper disposal of plastics eventually leads to pollution of groundwater, disturbance of soil microbial activity and release of carcinogenic chemicals in the atmosphere leading to problems of health among humans. Because of this value chain imbalance, the other life forms are also affected by stray cattle feeding on thrown-away plastics. These adverse effects alarm society and industry to ensure that plastics are properly disposed of. In addition, the Indian plastics processing industry is highly fragmented, with most units being small and micro players.

The plastics market in India is dependent on labor - intensive equipment that has adversely affected productivity. In India, unreliable power and high energy costs are also constraints that hamper capacity utilization compared to other countries[FICCI 2017]. Over 15,000 tons of plastic waste is produced in India every day. Eventually, a growing proportion of this plastic waste is found in rural areas as the reach of retail dealers increases also with an increasing number of small and micro scale plastic processing industries. [Swachh Bharat Mission, Plastic Waste Management, Draft Implementation Framework, Managing Plastics Waste in Rural India]. Plastic is a sustainable choice only when properly recycled and disposed off to enable processors to compete globally. This can be actually achieved primarily by segregating waste at source and promoting infrastructure for waste management. If plastics can be collected and disposed of or recycled in accordance with the guidelines / rules then the plastic waste issue can be addressed appropriately. There is wide ranging scope for industries that are based on plastic waste recycling. This will not only deal with the issue of degradation of the environment, but will also create capital. It will be a good idea to link plastic waste management with recycling industry prospects. Strategic shift of Indian plastic processing industry from low - output / low - tech machines to high - output, high - tech machines which are energy efficient is a necessity. [FICCI 2017, Bing X. et al., 2015 and Accorsi R. et al., 2014]

Supply Chain Management (SCM) has been identified as one of the key success areas for improving the effectiveness of plastic processing industries. Collaboration between different firms seems to be an essential approach to economic sustainability in order to mitigate the difficulty of acquiring their own competencies. Also, the issue of environmental costs arises with the rapid changes that exist throughout the world. Developing a plastic supply chain to control pollutant releases and enhance end-of-use waste recycling and further reprocessing can be a case of a green supply chain management approach to address these environmental concerns. Pollution control regulations by the government can also increase pressure on plastic processors. In addition, the environmental and social aspects are linked to the responsibility of the plastic processor. It has been driven by government in the past as indicated by social practices, but now firms need to take an initiative to lead the change [Kang S. H. et al., 2012]. Plastic waste should be actually treated as a resource and perhaps formal recycling industries developed to recycle plastic component from the waste, thus creating employment for rag pickers and absorbing them in the mainstream. In addition, promoting and maintaining health and safety measures across the plastic supply chain has the greatest impact on stakeholders ' physical, mental and social well-being and ensures that they are not harmed at any stage in the supply chain [Xu Jiuping et al., 2016]. Plastic processing companies and others in their supply chain can address these concerns successfully and build for future growth through collaborative action.

This call for action led to the development of the Plastic Green Supply Chain Management Framework (PGSCMF) in cooperation with a number of plastic processing companies. The implementation guide in this paper was developed to support the implementation of the plastic green supply chain management framework (PGSCMF) regardless of company's size or position in the plastic supply chain. This paper is intended as a useful guidance tool for fulfilling membership commitments made by members of the plastic supply chain; however it is not a membership requirement.

LITERATURE REVIEW

Literature review focuses mainly on previous studies that address sustainable issues related to business activities in the forward and reverse supply chains.

To achieve a greener supply chain and maintain competitive advantage, it is important to integrate environmental management practices into the entire supply chain management [Abu Seman 2012]. The literature contains various definitions of green supply chain management (GSCM). Accordingly, GSCM is defined by [Hervani A. A. & Sarkis J. 2005] as ranging from green purchases to integrated supply chains starting with suppliers, manufacturers, customers and reverse logistics, which is "closing the loop." According to [Srivastava S. K. 2007], GSCM can be defined as, integrating environmental thinking into supply chain management, including product design, supply and selection of materials, manufacturing process, final product delivery to consumers and end-of-life management of the product after its useful life [Kang S. H. et al. 2012]. Kang S. H. et al., established a framework for the development of a sustainable supply chain based on managerial and research implications. [Chardine Baumann E. & Botta Genoulaz V. 2014] proposed a sustainable performance framework characterizing a company's economic, environmental, social, health and safety sustainable performance. [Sundarakani B. et al., 2010] examined the carbon footprint across supply chains and showed that carbon emissions can pose a significant threat across stages in the supply chain that warrants careful attention during the design phase of supply chains. [Eirini A. et al., 2013] proposed a methodological framework for carbon footprint management throughout the supply chain and throughout the life cycle of the product. [Johanna A. B. & Jacobus D. 2011] checked whether the conceptual framework is a workable tool for firms to analyze their supply chain designs. [Bing X. & Vander Vorst J. 2015] gave an insight into emissions trading schemes (ETS) as a policy tool for emissions control that introduces trade-offs between economic efficiency and environmental impacts in re-processing to facilitate the reverse supply chain and prevent the spread of pollutants. It has become clear that best practices require environmental management to be integrated with ongoing operations [Abu Seman 2012].

Green supply-chain management (GSCM) is gaining increasing interest among plastic processors all over the world to tackle the probable risks in perspective of green supply chain. The past literature also shows that most researchers in developed countries have been studying the adoption and implementation of GSCM in plastic processing industries. Still limited studies have examined the GSCM practices across plastic processors in India.

Green Supply Chain Management in India

Green supply chain practice commonly is believed to represent the environmentally-friendly image of products, process, systems and technologies, and how the business is conducted [Abu Seman 2012]. Concern about the environmental issue has also rise the interest of researchers to investigate the adoption and implementation of green supply chain management practices in India. The study conducted by [Diabat A. & Govindan K. 2011] identified the drivers influencing the implementation of green supply chain management using an Interpretive Structural Modeling (ISM) methodology and extracted 11 drivers from past literature: certification of the environmental management system of suppliers; environmental collaboration with suppliers; collaboration between product designers and suppliers to reduce the number of drivers collected through past literature; [Mangla et al. 2015], from the point of view of Indian plastic industries, analyzed the risks involved in implementing the green initiatives. For several years, Asia has been the world's largest consumer of plastics, accounting for nearly 30% of global consumption. Following China, India is the second largest growing consumer and offers enormous business opportunities by incorporating environmental consideration with recycling and reuse operations. All India Plastics Manufacturers Association (AIPMA) report estimates that plastics is one of India's major contributors to GDP, and plastic consumption will increase from the existing 8 million tons per year in

India to nearly 2-3 times per year in 2020 [Plastic News, 2013].

Scope for Biodegradable Plastic

A lot of literature has been written about biodegradable plastics. This is a good catchword, but if one looks a little deeper, it can be seen that the promises made have major drawbacks. Biodegradable, single - use plastics can be composted only in an industrial environment and will not be degraded in landfill sites. Many plastics labeled biodegradable, such as shopping bags and thin gauge thermoformed food packaging, will only break down at temperatures above 50°C with UV light compostable industrial environments. There are none of these conditions in the oceans or landfill or in the corner of the street. Investing in industrial processes to compost biodegradable plastics does not make any sense when investing in recycling conventional plastics for reuse is more resource efficient. Christine Schulze, et.al, also studied the quantitative energy - related evaluation of manufacturing bioplastics compared to conventional plastics, resulting in similar specific energy consumption (SEC) in the processing of bioplastics and petrochemical materials [Schulze C. & Thiede S. 2017].

“The main solution to plastic menace in the landfill and ocean is improved waste collection and recycling, especially in the developing world” [UN Statement 2016].

Plastic Green Supply Chain Management (PGSCM) in India

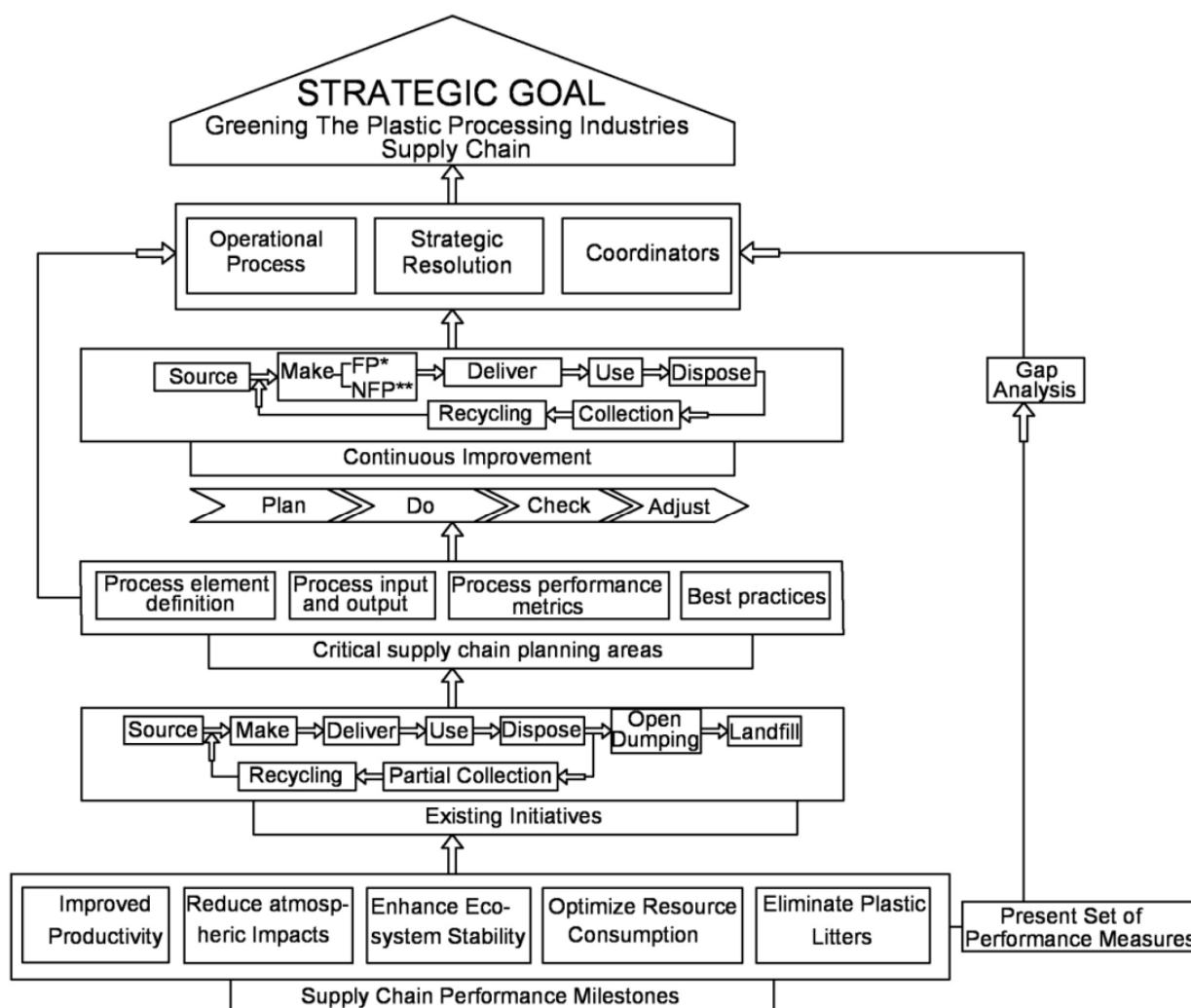
In India, plastic consumption, including recycling, will amount to 26,600 tons by 2030 [Mutha et al. 2005 & India Ltd. Credit Rating and Information Services (CRISIL) 2007]. Because of its sustainability over other materials, plastics consumption for packaging in India is about 42% [Golghate C. D. & Pawar M. S. 2012]. This indicates that the environmental burden is increasing due to plastic packagings. In the case of plastic packagings due to non- degradability, the non - conventional type of environmental burden is prominent. Furthermore, conventional environmental burdens are all along the supply chain partners due to old technology, management style and practices [Chaouki Ghenai 2012]. More than 15,000 tons of plastic wastes are produced every day throughout India. An increasing proportion of this plastic waste is eventually found in rural areas as the reach of retail corporations increases with an increasing numbers of small and micro scale plastic processing industries [Swachh Bharat Mission, Plastic Waste Management, Draft Implementation Framework, Managing Plastics Waste in Rural India, 2016]. In the opinion of [Golghate et al. 2015], the ‘design for manufacturing’, ‘design for environment’, ‘design for energy’, ‘design for recyclability’ tools are the best alternatives for reducing the environmental burdens of a plastic supply chain. The timely and economically viable implementation of the PGSCM practices requires the selection of the right tools to form the framework. Choosing tools to reduce the environmental burden depends on the intensity and net effect of the inventory release. Green supply chain literature solutions and frameworks are too widespread, specifically as described by [Hervani A. A. & Sarkis J. 2005] ; due to non-biodegradability and difficult to measure, the type of environmental burden imposed by plastic packaging, especially at the end-of-life stage, is of very different nature.

Furthermore, as a small-scale industry, the plastic industry cannot provide resource support to evolve from time to time with the customization of the framework and necessary upgrades. Therefore, implementation frameworks are always required to be simplified, time-tested and cost-effective. The framework approach should address the economic, environmental, social, health and safety concerns that are poorly measured and provide timely solutions for adoption. It is clear from the literature that although the green supply chain is a better approach, it is lagging in use as the necessary framework has yet to be developed. The next section describes the description of the framework.

How the Plastic Green Supply Chain Management Framework Works

The PGSCMF makes available an ‘umbrella’ mechanism for plastic processing industries to map and put together existing green supply chain management activities along with other similar companies in a logical way.

It helps to identify opportunities for activity development and prioritization to enhance performance and clarify options for making a more sustainable plastic processing industry. The objective is to act as the industry's flexible reference tool, bringing greater continuity and providing guidance on individual and collaborative actions while continuing innovation in approaches to address green supply chain management at a very specific and local level. The PGSCMF focuses on nineteen key performance metrics grouped among four performance categories, identified as relevant to the Indian plastic processing sector. The scope of the PGSCMF is the cradle to cradle plastic value supply chain. These nineteen performance metrics were selected on the basis of an independent and in-depth analysis of over a hundred local plastic and non - plastic stakeholder’s interviews. In addition to these metrics, more specific metrics may exist in a local context.



[*FP – Food Packaging, **NFP – Non-Food Packaging]

Figure 1: Plastic Green Supply Chain Management Framework (PGSCMF)



Figure 2: Performance Metrics

Strategic Goals of the PGSCMF

Each of the nineteen key metrics has a strategic goal. Strategic plastic green supply chain management framework is what the case company has agreed to pursue in undertaking activities within each of the 19 metrics. In the PGSCMF these are defined as:

Table 1: Strategic Goals of the PGSCMF

Performance Category	Performance Metric	Strategic Goal
Economic	Specific Energy Consumption (SEC)	Developing energy management team to conduct energy audit and arrest energy losses.
	Process waste	Achieving more output of product per unit of input of raw materials.
	Waste recycling	Unavoidable plastic process waste and end-of-use waste is recycled to the maximum extent.
	Recyclate in RM mix	Increase in reprocessing of recycled material.
	Overall Equipment Effectiveness (OEE)	Increase in manufacturing time that is truly productive.
	Inbound and outbound Logistic	Transportation management to reduce freight expenses and increase overall supply chain efficiency.
	Processing technology	Increasing the degree of automation and adopting lean tools and techniques to reduce production cost, increasing efficiency with improved quality and reliability.
	User phase of the product	Enabling users to effectively and efficiently achieve their end objective with a product.
	Buyer- Suppliers relationship level	Maintaining good relationship with suppliers.
Environment	Water consumption	Water availability, as well as water quality, is managed responsibly throughout the plastic supply chain.
	Green Warming Potential (GWP)	During plastic processing and logistics across the supply chain, emissions that trap heat; CO ₂ , CH ₄ , and other GHG emissions are reduced through all economically viable mechanisms.
	Acidification Potential (AP)	To prevent damage to plants, animals and structures, the potential for acidifying pollutants (SO ₂ , NO _x , HCl, NH ₃ , HF) to form H ⁺ ions is controlled.
	Photochemical Oxidation Potential (POP)	Provide adequate ventilation to ensure a healthy working environment, optimum plastic product quality and safety.

	Environmental management system	Efforts to improve environmental performance by reducing polluting environmental releases.
	Renewable energy	Investment in renewable energy sources to reduce our dependence on fossil fuels and oil reserves.
Social	Living environment	Executing philanthropic activities like installing plastic waste collectors at public places.
	Extended producer responsibility (EPR)	Focus on end-of-use treatment of plastic products to increase product recovery and minimize the impact of waste materials on the environment.
Health and Safety	lost-time injuries	Reduced lost-time injuries. Workers operate in a safe environment throughout the plastic supply chain and their rights (based on declarations accepted internationally) are respected and promoted.
	Human toxicity potential	Deterrence to toxic chemicals that can cause cancer or other negative effects on humans.

Membership Commitments

The membership reporting commitments to the PGSCMF are shown below for a period of four years,

Table 2: Yearly Membership Reporting Commitments

Year 1	Year 2	Year 3	Year 4
Endorse the performance categories, metrics and strategic goals	Review existing schemes and modify them according to PGSCMF metrics and strategic goals as priorities for the local region	Implement new programs with indicators of performance and appropriate targets.	Evaluate existing schemes
Establish adequate control mechanism within the firm to 'implement the PGSCMF	Review or develop new indicators of performance for existing schemes	Relevant progress reporting to the PGSCMF controlling authority to update existing schemes	Reporting to PGSCMF of changes/progress
Prioritize the nineteen metrics and strategic goals for the local region	Report to the PGSCMF controlling authority all new activity and performance targets	Provide required reporting for aggregation and profiling to PGSCMF controlling authority	
Provide basic business and existing scheme information, including existing sustainability efforts, to the PGSCMF controlling authority.	Provide progress reports to the PGSCMF Controlling authority on existing schemes		

Implementation Guide

Plastic processing systems vary widely throughout the world, with particularly noticeable variation between developed and developing countries. There are differences in the local environment, regulations and interest of stakeholders. It makes more sense to seek national / local implementation rather than striving to meet a global benchmark, given that regions share similar challenges and opportunities for green supply chain management. The purpose of this paper is to assist in facilitating the national / local implementation of the PGSCMF. This includes understanding the obligation of members of the PGSCMF to effectively implement the PGSCMF. The PGSCMF takes a different approach to other product sustainability programs and as such we have to make sure there is an adequate level of robustness in its delivery process to comfort those interested in the plastic supply chain's sustainability performance. In order to quantify the

green supply chain performance of the plastic sector as a whole, a supply chain performance evaluation and measurement method is developed to collect information on the implementation and subsequent performance of individual initiatives. The spectrum of continuous improvements is a key part of the PGSCMF and is based on the approach of the international PDCA, or Plan - Do - Check - Adjust. In the national / local implementation guide steps, the stages of the spectrum of continuous improvements ('Plan', 'Do', 'Check', 'Adjust') are actually worked through sequentially.

Activation Steps

The following eight steps are suggested to be followed while implementing the PGSCMF. These steps follow the cycle of "Plan," "Do," "Check," "Adjust".

- Orientation on plastic green supply chain management
- Plastic green supply chain management commitment
- Prioritization of Material Issues
- Improvement planning
- Implementing the action plan
- Performance measurement
- Reporting and communication
- Continuous performance improvement

Facilitators support the steps and are critical to the PGSCMF implementation. The two facilitators identified by PGSCMF are: 1.Firmscontrollingauthority2.Stakeholder engagement

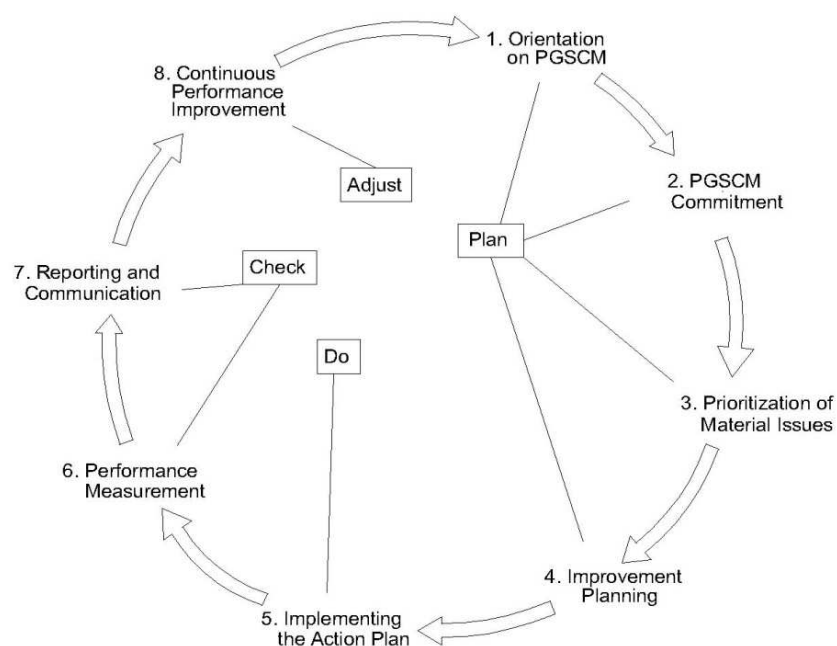


Figure 3: PGSCMF Implementation Guide

The steps in this framework are derived from the internationally recognized ISO 14000 standard of best practices. To understand the steps in more detail, it is recommended that members of the PGSCMF take time to consider the implementation of ISO 14000 and publicly available guidelines. ISO 14000 provides guidance on how firms can operate in a socially responsible manner, which means acting in an ethical and transparent manner that adds value to the environmental and societal health and welfare. ISO 14000 helps clarify what social responsibility is and help firms to translate principles into effective actions and provides good practice examples. It is intended for all types of firms irrespective of their activity, size or location.

Facilitators

Controlling Authority of the Firm

In order to integrate green supply chain management successfully within the firm, it is essential to design and operate decision - making systems to incorporate green supply chain management - based principles. Firms controlling authority structure is an ongoing process, similar to stakeholder engagement. This process is essential as it will support efforts to ensure successful implementation of supply chain activities and planning. It is essential to have a good authority structure from the outset to implement a plastic green supply chain approach. Depending on the firm's organizational structure, the authoritative control required will differ, but it is generally important to have commitment from the management and suppliers. It is also advisable, when working together in a regional approach, to set up a steering group, including high - level representatives from plastic producers and their processors, to support the entire process and provide steering opportunities.

Stakeholders Engagement

Stakeholders are individuals or groups interested in any firm's decision or activity. The firm should understand its relationship between the stakeholders and society (recognizing that stakeholders belong to society and have specific interests). This means taking into consideration the decisions and activities that have an overall impact on society, animals and the environment as well as the identified specific stake holders. In general, how many stakeholders should be involved is difficult to describe. The first step is to prepare stakeholders overview based on local and national knowledge. Prioritization can be carried out on the basis of criteria such as influence and impact on the enterprises. The involvement of stakeholders involves two-way discussions on the best way to work together. It is an integral and continuing part of the process of activation and is not a one - time exercise. It is recommended to engage with stakeholders at each step and genuinely seek input from them.

While stakeholder engagement can be new and challenging for the business but it can be very rewarding. This is actually where the PGSCMF's power is expressed. It doesn't rely on a group sitting in an office where the authorities decide what is important for an enterprise in greening its supply chain. It is the plastic processing company and the local stakeholders who work together and agree on issues, mitigation programs, success measures, evaluating and reporting the progress together.

To benefit fully from this process, one must first ensure that management is aware of the ongoing nature of involvement of stakeholders and is comfortable with it. Do not try to involve all stakeholders on all issues initially. Instead:

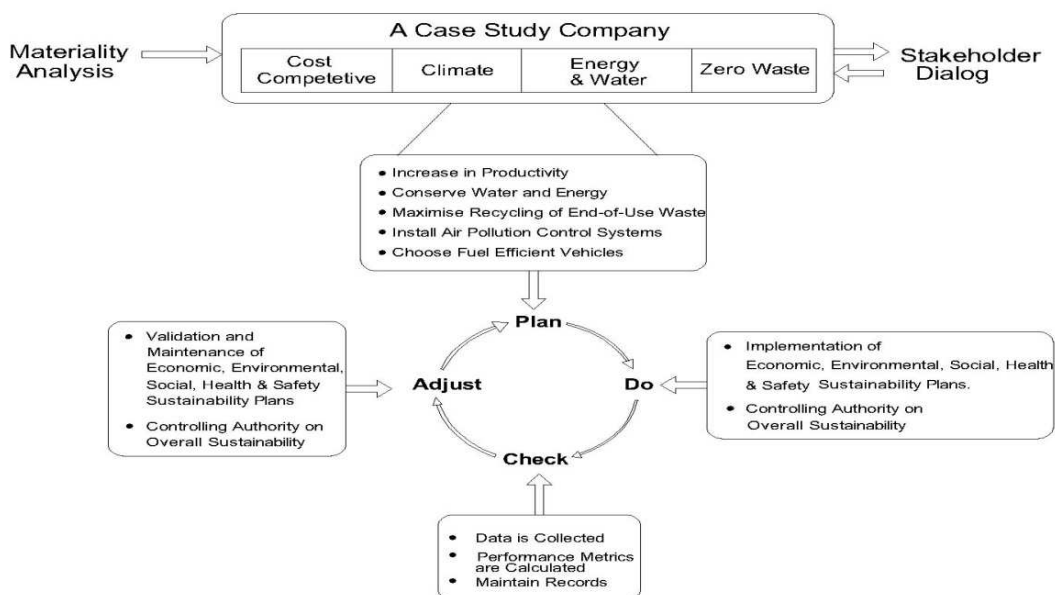


Figure 5: Case Study Example- Plastic Thermoforming Green Supply Chain Management

Management Process

Orientation on Plastic Green Supply Chain Management

Green supply chain management covers a wide area. For companies with no experience in this field, an orientation phase can be very useful. The content of the green supply chain management field can be investigated in this orientation phase, stakeholders expectations can be explored and competitive steps can be developed in the market.

Plastic Green Supply Chain Management Commitment

To successfully implement the PGSCMF, Management in the company is crucial that agrees and commits to sustainability. Management plays an important role in decision-making on strategic direction, planning, policy and standards, availability of resources, change in culture and budget. All of these are important components of embedding green supply chain management practices within a plastic processing company, so it is critical that management is supportive and knows what is needed to implement the PGSCMF. Sustainability commitments can already be stated in existing policies, public commitment, documents or past strategies. If that's the case, then check for alignment with the vision and nineteen metrics of the PGSCMF. Firms are recommended to use the vision of the PGSCMF in the early development phase; this provides a suitable and aligned starting point.

Vision statement: A vibrant plastics industry committed to continuously enhancing its capacity to deliver sustainability in economic, environmental, social and health & safety.

Prioritization of Material Issues

This step is to evaluate each of the nineteen PGSCMF metrics. Materiality analysis comprises identifying what is important for the plastic processing company and its stakeholders. Discovering what is 'material' in the action planning step will help the company focus on what it needs to do. A plastic processing company cannot do it all at once, after all. Some metrics are more relevant than others and it is necessary to determine these. The steps below are an example of how to analyze 'material' issues.

Step1: Identification

The first step is to identify the green supply chain management issues that are most relevant to the particular situation using the nineteen key metrics as a starting point with the firm's organizational structure including stakeholders. These are comprehensive and they provide necessary structure for investigating which issues are most relevant to local or national circumstances.

Step2: Prioritization

The next step is to prioritize these issues upon identifying the list of relevant material issues. A ranking methodology must be designed to prioritize. There are different ways to rank, but in this collaborative process, whatever method is chosen, the perspectives of stakeholders need to be considered.

Step3: Review

After the list has been reduced to priority issues, Management should verify and confirm that these are relevant issues the company should focus on improvements and efforts in action planning. As noted above, the PGSCMF is not about simultaneously delivering activity on all 19 metrics. It is about identifying which are the most important with the stakeholders, through a process of prioritization, and then collaboratively determining what to do to address these identified and prioritized metrics.

Improvement Planning

The next step to activate the PGSCMF is developing action plans on the basis of priorities. Dealing should begin by conducting a current evaluation of the prioritized metrics, followed by analyzing the gap closure. Once gaps are identified, it is important to identify and focus in order to address the challenging criteria before writing an implementation plan. It is best practice to work with the stakeholders in this process to choose which gap activities to implement. There are also many options for selecting activities. Below is an example involving three steps:

- **Impact** – What are the needs and potential benefits, risks and opportunities of stakeholders?
- **Capability** – What are these activities going to cost?
- **Visibility** – are these activities going to create momentum for greater change?

The next step is to draft the action plan after selecting which activities to pursue. Suggestions for consideration when drawing up the plan are given below:

- Identify material issues and relevant PGSCMF metrics.
- Explain the desired goals to be achieved by the firm.
- Provide processing descriptions - which allow supply chain members to use creativity and exercise moral responsibility. For instance, if the plastic green supply chain management framework cannot be achieved by any supply chain member, a list can be drawn up together with possible applications.
- Maintain the plan realistic.

- Allocate sufficient resources within the company organization (money, people with authority, time) to make it work and support its supply chain members with workshops, organizing processes, etc.
- Set deadlines and key milestones for the completion and assessment of the plan, including reporting to stakeholders.

This plan will form part of future reports and involvement of stakeholders. This can be used by the plastic processor, stakeholders and auditors to assess the commitment to ongoing progress in implementing the PGSCMF.

Operational Process

Implementing the Action Plan

The most important step in the process is the implementation of the green supply chain management plan. After all, without proper implementation the whole process means generating a lot of paper. Implementing activities to close the gaps involves all supply chain partners. This includes plastic processors, suppliers, distributors, dealers and plastic recyclers from third parties. Making the plan 'real' necessitates community and stakeholder support. People need to be educated to understand the importance of source segregation at the point of generation as biodegradable and plastic for proper waste management. It is usually best practice to start raising awareness of the plan or activities among supply chain members and stakeholders, and then follow up by constantly showing progress and 'easy wins', like cost savings (e.g. gains in energy efficiency) and controlling environmental pollutant releases. Effectively implemented, these will build buy-in over time for the plan and momentum for other green supply chain management initiatives to be adopted. One can communicate the progress and success among the stakeholders (through the Self - imposed process of evaluation).

Control Processes

Performance Measurement

Performance measurement and recording indicators are an essential part of the green supply chain management embedding process. It is necessary to establish a valid performance measurement system to provide objective proof that the activities undertaken meet the comprehensive metrics of the PGSCMF's strategic goal statement.

The following table provides an example of a performance indicator per metric used in the measuring process.

Table 3: Performance Indicators

Category	Metric	Performance Indicator	Objectives	Relevant Area
Economic	Specific Energy Consumption (SEC)	$\frac{kWh}{kgs.ofplasticprocessed}$	Energy efficient plastic processing	Processing
	Process waste	% of total plastic processed	Efforts to reduce waste	Processing
	Waste recycling	% of waste recycles	Reduce landfill by recycling	Processing
	Recyclate in RM mix	% of virgin plastic resin	Reprocessing	Processing, Third party recyclers
	Overall Equipment Effectiveness (OEE)	Availability x Performance x Quality	Improved productivity	Processing
	Inbound and outbound Logistic	Saving in diesel consumption	To reduce freight expenses and increase overall supply chain efficiency.	Suppliers, Processing, Marketing

	Processing technology	Increased efficiency	Maximum throughput and energy efficient processing	Processing
	User phase of the product	Customer satisfaction		Market
	Buyer- Suppliers relationship level	Retention ratio	Healthy relationship	Market
Environment	Water consumption	Units (1 unit= 1000 ltrs.)		Processing
	Green Warming Potential (GWP)	CO ₂ equivalents	Reduction in emissions that trap heat	Processing, Logistics
	Acidification Potential (AP)	SO ₂ equivalents	Reduce Your Carbon Footprint.	Processing, Logistics
	Photochemical Oxidation Potential (POP)	C ₂ H ₄ equivalents	Avoid chemicals and vehicles that release high levels of VOCs	Processing, Logistics
	Environmental management system	Accreditation ISO 14000	Standardization of system	Processing
	Renewable energy	Return on Investment	Reduce our dependence on fossil fuels	Processing
Social	Living environment	Clean public places	Preferred location by society	Public places
	Extended producer responsibility (EPR)	Price of the product includes the cost of its safe disposal	Reduction in environmental impact of the waste	Public places
Health & Safety	Lost-time injuries	Fatality or injury	Good working conditions	Processing
	Human toxicity potential	2,3,7,8-tetrachlorodibenzo-p-dioxin	Practices of burning plastic trash should be eliminated, not only because of dioxins, but also to curb carcinogenic polyaromatic hydrocarbons.	Processing, logistics, Public places

Reporting and Communication

The report can be used to engage the stakeholders, customers, shareholders and investors. The report documents the PGSCMF commitments and action plan over time to address the identified material issues and improvements. The report creation provides an opportunity to the companies who adopted PGSCMF to reflect, evaluate and assess their efforts. At the same time, for the years to come, one can make suggestions and changes to the plans. Not only does the report help others to understand the business, it also helps to connect current efforts with the future. Reporting is an important step in improving continuously.

Continuous Performance Improvement

The process of measuring, analyzing and reporting leads to information on the next challenges in the implementation of the PGSCMF. Improvement may involve small steps or major steps - the main objective is to improve. Green supply chain management work is an ongoing process that can be followed only by continuous improvement.

CONCLUSIONS

Governing a green supply chain for plastics is an endless process. Meanwhile, as society and the environment change, the material issues will change, so it is important that the steps outlined in this paper should be re-evaluated every year. Firstly a gap analysis was undertaken to identify any gaps in the coverage to support the plastic processor in working

towards the metrics and strategic goals of the PGSCMF. It is important to note that good management of any plastic supply chain is the basis of economic, environmental, social and health & safety sustainability of the system. It therefore pays first attention to effective planning and management of the supply chain as a whole.

Not only are these records important for supply chain agreements or legal responsibilities as evidence, they are also an invaluable resource for quantifying the continuous green supply chain performance and improving the plastic processing unit. Records can be used for year-to-year performance as a benchmark / comparator based on varying levels of input / practices even at their most basic level. Without these, changes in output performance are extremely difficult to appreciate.

Economic Sustainability

- Plastic business viability – Considering the potential for increased productivity, mix of supply chain businesses, product quality, stakeholder health and safety, market opportunities and access.

Social Sustainability

- Social and Human capital – Ensure that all those responsible for the plastic supply chain are provided with the appropriate skills and knowledge to fulfill their responsibilities and have an appropriate and legal working environment.
- Local community /economy - The plastics business must look for ways to contribute to the resilience and vitality of the local community

Environmental Sustainability

- Water –Water is managed proactively and strategically in a sustainable manner.
- Energy – Continuously strive to optimize energy consumption by prioritizing renewable energy inputs into the plastic processing system
- Waste – It is the responsibility of the plastic processing company to reduce, reuse and, if necessary, recycle or disposal of waste in a safe manner that does not cause pollution.

Health and Safety Sustainability

- Protecting workers safety in plastics processing companies is an important part of managing health and safety.
- Standardizing the working systems with warning signs, labels and instruction.
- Plastic processing companies need to prevent their employees being injured as a result of manual handling activities by introducing automation in material handling

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